

A.27 Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

A.27.1 Legal Status

The vernal pool fairy shrimp (*Branchinecta lynchi*) is listed as threatened under the Federal Endangered Species Act throughout its range (59 FR 48136). In September, 2007, USFWS published a 5-year review recommending that the species remain listed as threatened. Revised critical habitat was designated on February 10, 2006 (71 FR 7118). This species is covered by the December 15, 2005, Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005). Only one unit, 19B, is partially within the BDCP Planning Area boundary.

The vernal pool fairy shrimp has no state regulatory status.

A.27.2 Species Distribution and Status

Range and Status

The vernal pool fairy shrimp was identified in 1990 (Eng et al. 1990) and there is little information on the historical range of the species. It has the largest geographical range of listed fairy shrimp in California, but is seldom abundant (Eng et al. 1990). The species is currently found in disjunct and fragmented habitats across the Central Valley of California from Shasta County to Tulare County and the central and southern Coast Ranges from northern Solano County to Ventura County, California (Figure A.27.1) (USFWS 2005, 2007, CNDDDB 2008). Additional disjunct occurrences have been identified in southern California and in Jackson County, Oregon. In California it occurs in a wide range of vernal pools and in the Altamont Pass area (Contra Costa and Alameda Counties) it occurs in clear-water depression pools in sandstone outcrops (Eng et al 1990, Ericksen and Belk 1999, CNDDDB 2008).

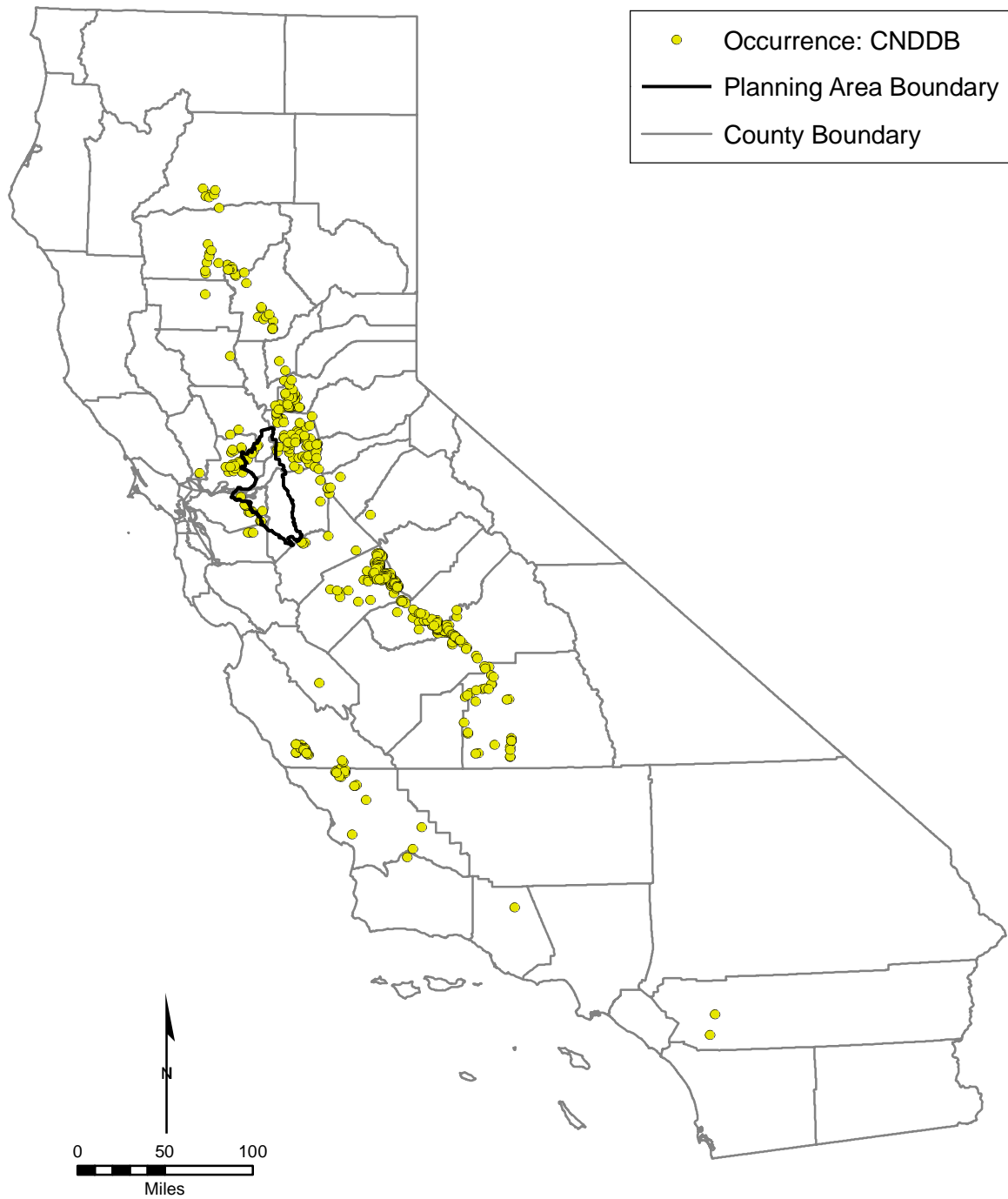
Distribution and Status in the Planning Area

Vernal pool fairy shrimp have been reported from several locations within the BDCP Planning Area (Figure A.27.2) (USFWS 2005, 2007, CNDDDB 2008). In general, within the BDCP Planning Area vernal pools that may support the species occur on alkaline soils from the DFG Tule Ranch Reserve southwest to the Montezuma Wetlands Mitigation Projects and from the Byron Airport to Discovery Bay. Other potential vernal pool habitat occurs along the eastern boundary of the BDCP Planning Area near Stone Lakes.

A.27.3 Habitat Requirements and Special Conditions

This species is entirely dependent on the aquatic environment provided by vernal pool and sandstone depression pool ecosystems. Typical habitat for vernal pool fairy shrimp in California includes vernal pools, seasonally ponded areas within vernal swales, rock outcrop ephemeral pools, playas, and alkali flats (Eng et al. 1990). Vernal pool fairy shrimp have been found in pools ranging from 0.1 to 1.5 acres (Eriksen and Belk 1999) and in sandstone depression pools that are less than 1.6 feet diameter (Eng et al. 1990).

The vernal pool fairy shrimp is a component of a larger invertebrate community structure (Rogers 1998). This invertebrate community includes mostly planktonic Crustacea dependent on



Source: California Department of Fish and Game, CNDDB, 2008.

Figure A.27.1. Vernal Pool Fairy Shrimp Statewide Recorded Occurrences

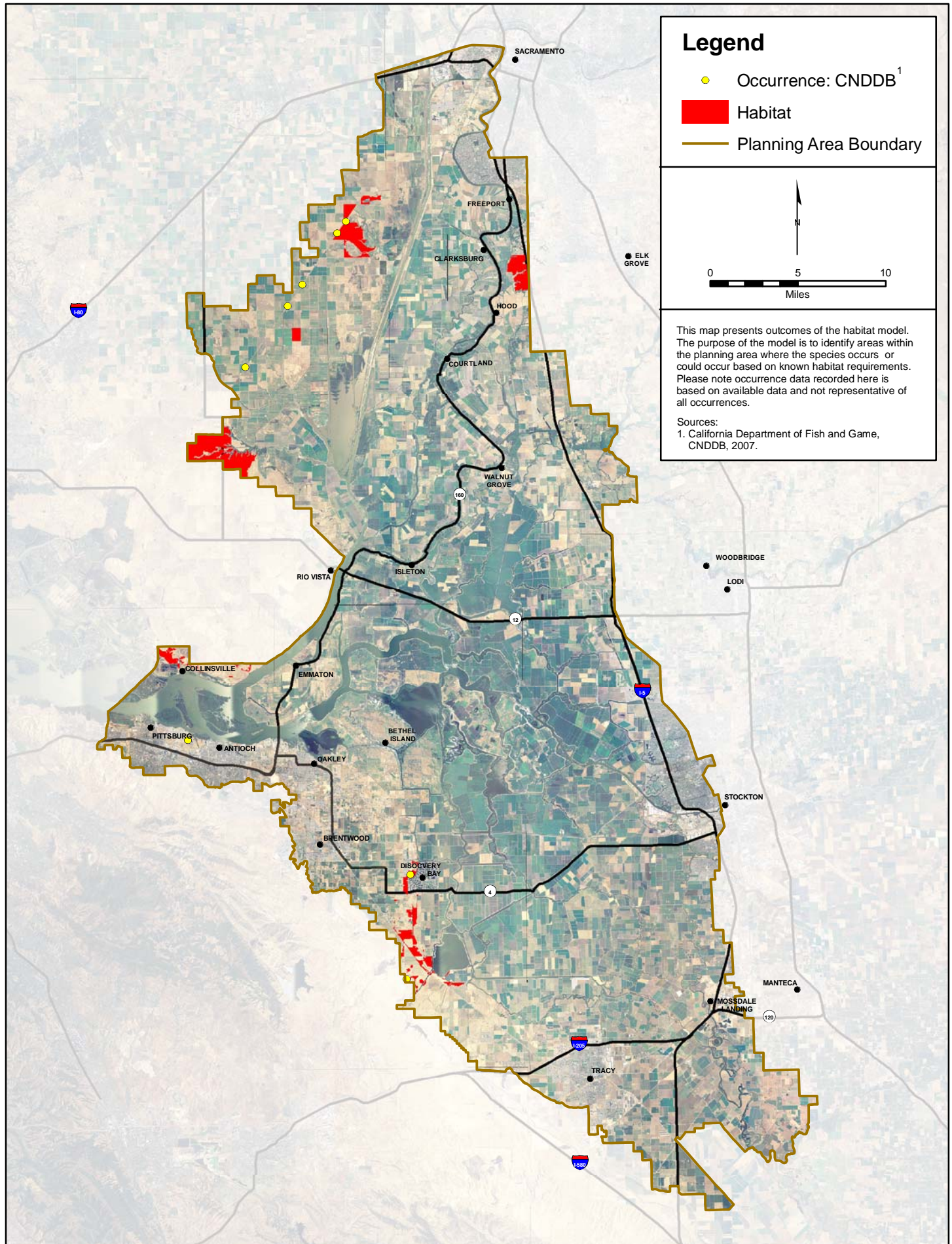


Figure A.27.2. Vernal Pool Fairy Shrimp Habitat Model and Recorded Occurrences

temporary wetlands, including copepods, cladocerans, and ostracodes as well as flatworms and a suite of insect species, including vernal pool halipid beetle (*Apterliplus parvulus*), scimitar backswimmers (*Buenoa scimitra*), Ricksecker's hydrochara (*Hydrochara rickseckeri*), and many others (Rogers 1998). These habitats are usually low in opportunistic species like mosquitoes and chironomid midges in the genus *Chironomus* that can survive in waters with very low concentrations of dissolved oxygen (Rogers 1998).

A.27.4 Life History

Feeding. Vernal pool fairy shrimp is an omnivorous filter-feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999).

Ecology. Vernal pool fairy shrimp are adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of the vernal pool fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may comprise eggs from several years of breeding (USFWS 2005, 2007).

Vernal pool fairy shrimp has a relatively short life span which allows it to hatch, mature to adulthood, and reproduce during the short time period when vernal pools contain water. When reared in plastic pools with their bottoms lined with soil excavated from vernal pools and without supplemental food this species completed its lifecycle in an average time of 26 days (Helm 1998). It has been reported to co-occur in the same general area with the longhorn fairy shrimp (*Branchinecta longiantenna*) but the species did not occupy the same vernal pools (Eng et al. 1990).

A.27.5 Threats and Stressors

Threats to vernal pool habitat and species in general, including vernal pool fairy shrimp, were identified in the Recovery Plan (USFWS 2005, 2007). In addition, the Recovery Plan identified several threats specific to the vernal pool fairy shrimp. Within the entire range of the species, more than half of the known populations of vernal pool fairy shrimp are threatened by development or agricultural conversion. Several populations are found on military bases, and although not an immediate threat, military activities can result in alteration of pool characteristics, including introduction of non-native plant species (USFWS 2005, 2007).

Habitat loss and Fragmentation. Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of urbanization, agricultural conversion, and mining and can also occur as a result of habitat alteration and degradation due to changes to natural hydrology, invasive species, incompatible grazing regimes (including insufficient grazing for prolonged periods) (Marty 2004), infrastructure projects (such as roads and utility projects), recreational activities (such as off-highway vehicles and hiking), erosion, climatic and environmental change, and contamination.

Habitat fragmentation is also related to habitat loss when individual vernal pools become disconnected and isolated as a result of activities such as road development and other infrastructure projects. Widespread urbanization and the construction of infrastructure are major contributors to the loss of vernal pool habitats and their associated species. Decreases in waterfowl and shorebird visitation due to habitat fragmentation can prevent genetic flow between habitats. In addition, gravel and clay mining operations that are needed to support urban development, including roads and other infrastructure, have resulted in the destruction of vernal pools (USFWS 2005, 2007).

Agricultural Conversion and Incompatible Livestock Grazing Practices. Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005).

Competition from Invasive Species. Vernal pool plant species have declined due to the introduction of invasive non-native plant and animal species. Increasing dominance by competitors may also contribute to changes in hydrology and livestock grazing practices (Marty 2004). At Camp Roberts in San Luis Obispo County, and in Butte County, the non-native invasive medusa head (*Taeniatherum caput-medusae*) threatened to diminish the pool area available to vernal pool fairy shrimp in two of three plots that were fenced to protect vernal pools from training activities (USFWS 2005). The decomposition of the dead litter of invasive grasses can reduce oxygen in the pools (Rogers 1998).

Altered Hydrology. Changes in hydrology that result in a change in the timing, frequency, and duration of inundation in vernal pools can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005). The vernal pool complexes in areas proposed for road improvements could be affected by alteration of hydrology which could diminish habitat for vernal pool fairy shrimp (CNDDDB 2008). Damage to the watershed that supports vernal pools and vernal pool complexes will affect vernal pool invertebrate communities. Elimination of the watershed will not allow the pools to pond properly and will curtail the movement of nutrients into the pool from overland flow (Rogers 1998).

Contamination. Slight changes in water chemistry directly affect sensitive vernal pool species, especially vernal pool crustaceans. Water contamination can occur from herbicides, fertilizers, road runoff, and other chemicals commonly used in urban and agricultural settings. Pesticide applications for combating West Nile virus, a disease transmitted by infected mosquitoes, may also affect fairy shrimp species. Fertilizers may also contribute to the growth of invasive plants (USFWS 2005).

Other threats. Several other threats to vernal pools and their associate species in general were identified in the Recovery Plan. Although not specifically identified as a threat to vernal pool fairy shrimp, these threats contribute to the decline of vernal pool habitats, which will affect all species that are dependant on functional vernal pool habitats for survival. Human use and recreational activities, such as off-road vehicle use, hiking, and bicycling, threaten vernal pool ecosystems. When access roads or trails are through vernal pool complexes, hydrological functions may be impaired by displaced soil causing erosion or interrupting swale connectivity. Also, off-road enthusiasts, such as bicyclists, may create dirt jump ramps, which also could result in the burial of seeds and cysts of plants and animals or soil compaction. Recreational users also may introduce, or facilitate spread of, invasive plants or dispose waste and debris into vernal pool habitat and alter the ecology (USFWS 2005).

Habitat alteration may also occur due to large-scale climate and environmental changes, such as global warming, which lead to changes in the precipitation pattern and atmospheric conditions. Most of the populations of vernal pool fairy shrimp are isolated from other populations and are distributed in discontinuous vernal pool systems. Small, isolated populations are vulnerable, which could result in extirpation from a particular area (USFWS 2005, 2007).

A.27.6 Relevant Conservation Efforts

A total of 597,821 acres, occupying 30 units, has been designated as critical habitat within the state of California (71 FR 7118). In addition, approximately 13,000 acres of vernal pool habitats, including mitigation banks, have been set aside for the vernal pool fairy shrimp specifically as terms and conditions of Section 7 consultations. These areas are scattered throughout the Central Valley and represent important building blocks toward recovery of the vernal pool fairy shrimp. Throughout the range of the species, vernal pool habitats supporting populations of vernal pool fairy shrimp have been protected through a variety of other means, including preserves, refuges, and protections on private lands. In the Solano-Colusa Vernal Pool Region, vernal pool fairy shrimp are protected in the Jepson Prairie Ecosystem, including the DFG Tule Ranch Preserve, Burke Ranch, Jepson Prairie Preserve, and Montezuma Wetlands Mitigation owned by the Solano County Open Space and Farmland Conservancy (USFWS 2005, 2007). Known occurrences in sandstone depression pools in the Altamont area are protected in the Brushy Peak and Vasco Caves preserves that are on property owned and managed by the East Bay Regional Parks District (USFWS 2007).

The vernal pool fairy shrimp is covered under the approved San Joaquin County and East Contra Costa Habitat Conservation Plans. In addition, the species is proposed for coverage under the Solano County, South Sacramento County, and Yolo County Habitat Conservation Plans that under development.

A.27.7 Species Habitat Suitability Model

Habitat. Vernal pool fairy shrimp habitat was identified in areas with alkaline soils as Natural Seasonal Wetlands and Grasslands on Antioch (AoA), Capay (Ca, Cc), Clear Lake (Ck), Diablo (DaC), Hillgate (HcA), Marcuse (Mb, Mc, Sb), Marvin (Mf), Pescadero (Pc, Pk), Rincon (Rg), Scribner (245), and Solano (Sh, Sk) soils (Figure A.27.2). For areas along the eastern border of the BDCP Planning Area that do not occur on alkaline soils habitat was determined by the presence of vernal pool and swale microtopography. Vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP GIS vegetation data layer (Hickson and Keeler-Wolf 2007). Aerial imagery (USDA 2005) and LiDAR elevation data (DWR 2007) were used to determine how intensively parcels included in the model had been farmed as the vegetation data included significant areas of fallow agricultural land that had been misclassified by DFG as various classes of natural vegetation. Sites without natural vernal pool and swale vegetation signatures and microtopography were deleted from the area of predicted habitat. Additionally, sites with known occurrences were digitized and included as habitat.

Assumptions. Historical and current records of this species in the BDCP Planning Area indicate that its current distribution is limited to areas with intact vernal pool and swale microtopography along the upland edges of the BDCP Planning Area (Witham 2003, 2006, CNDDDB 2008). Artificial impoundments such as stock ponds or roadside ditches, that are known to provide habitat for this species, were not included in the model.

A.27.8 Recovery Goals

A general statement for recovery of vernal pool fairy shrimp is presented in the USFWS (2005) Recovery Plan: to ensure protection of the full geographic, genetic, and ecological extent of this species and to improve the circumstances that caused it to be listed in the first place. Accomplishment of this goal would be achieved by protecting 80 percent of species occurrences throughout its range, including 85 percent of its suitable habitat in 38 Core Areas. In addition, the species would be reintroduced into vernal pool regions and soil types from which surveys indicate that it has been eradicated.

Literature Cited

- CNDDB (California Natural Diversity Data Base RareFind). 2008. California Department of Fish and Game, Sacramento, CA. Ver. 3.1.0 with data generated on June 29, 2008.
- DWR (California Department of Water Resources). 2007. Sacramento-San Joaquin Delta LiDAR surveys.
- Eng, L., D. Belk, and C. Eriksen. 1990. Californian Anostraca: Distribution, Habitat, and Status. *Journal of Crustacean Biology* 10:247-277.
- Eriksen, C. and D. Belk. 1999. Fairy shrimps of California's pools, puddles, and playas. Mad River Press, Eureka, CA.
- Helm, B. 1998. Biogeography of eight large branchiopods endemic to California. In: Witham, C.W., E.T. Bauder, D. Belk, W.R. Ferrin Jr., R. Orduff (eds.). Ecology, conservation, and management of vernal pool ecosystems – proceedings from a 1996 conference. California Native Plant Society, Sacramento, CA. pp. 124-139.
- Hickson, D., T. Keeler-Wolf. 2007. Vegetation and land-use classification and map of the Sacramento-San Joaquin River Delta. Report to the Bay Delta Region of the California Dept. of Fish and Game. Sacramento, CA.
- Marty, J. 2004. Effects of cattle grazing on diversity in ephemeral wetlands. *Conservation Biology*. 19: 1626-1632.
- Rogers, D.C. 1998. Aquatic macroinvertebrate occurrences and population trends in constructed and natural vernal pools in Folsom, California. In: Witham, C.W., E.T. Bauder, D. Belk, W.R. Ferrin Jr., R. Orduff (eds.). Ecology, conservation, and management of vernal pool ecosystems – proceedings from a 1996 conference. California Native Plant Society, Sacramento, CA. pp. 224-235.
- USDA (U. S. Department of Agriculture). 2005. National Agricultural Imaging Program.
- USFWS (U.S. Fish and Wildlife Service). 2005. Recovery plan for Vernal Pool Ecosystems of California and Southern Oregon. Available at:
http://www.fws.gov/sacramento/es/recovery_plans/vp_recovery_plan_links.htm.

USFWS (U.S. Fish and Wildlife Service). 2007. Vernal Pool Fairy Shrimp, *Brachinecta lynchi* 5-year Review. Available at: http://www.fws.gov/sacramento/es/5_year_reviews.htm.

Witham, C.W. 2003. Tule Ranch vernal pools botanical resources survey report. Yolo Basin Foundation, Davis, CA.

Witham, C.W. 2006. Greater Jepson Prairie ecosystem regional management plan. Fairfield: Solano Land Trust.

Federal Register Notices Cited

59 FR 48136. 1994. Final Rule: Endangered and Threatened Wildlife and Plants: Determination of endangered status for the conservancy fairy shrimp, longhorn fairy shrimp, and the vernal pool tadpole shrimp; and threatened status for the vernal pool fairy shrimp. Federal Register 59: 48136.

71 FR 7118. 2006. Final Rule: Endangered and Threatened Wildlife and Plants: Designation of critical habitat for four vernal pool crustaceans and eleven vernal pool plants. Federal Register 71: 7118.